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THE MODERN STUDY OF MINERALS¹

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For an understanding of the modern conditions of mineralogy, or of any other science, it is well to cast a glance backward to see what our predecessors have or have not done; we may learn from their errors of omission or commission, or we may find that some things now regarded as novel were discovered many years ago. In his presidential address of 1922, Professor T. L. Walker² has traced "The Development of Mineralogical Methods," so that I need say little of this aspect of the matter. But the attention of mineralogists may be called to a book, little read nowadays but of perennial value, by William Whewell, D.D.³ As Whewell was a mineralogist of note in his day, the native calcium oxalate being named after him, his chapter on the early history of mineralogy is of special interest to members of the Society.

Whewell, as does Herbert Spencer later, points out the three stages of a science. The first, which we may call the stage of infancy, is devoted to the collection of facts: a stage which in all sciences, as in the lives of human beings, persists through all the periods. Next, the stage of adolescence, is that in which the facts are correlated and the subject matter is classified. In the third stage, that of maturity, generalizations are drawn from the correlated facts and even, the crowning test of validity, verifiable predictions are made. The sciences may be likened to the gods of ancient Greece and Rome, for they do not grow old

¹ Presidential address, presented at the fifth annual meeting of The Mineralogical Society of America, Ithaca, New York, December 31, 1924.

² T. L. Walker, *Am. Min.*, 8, 41, 1923. In my choice of subject I fear that I have trenched somewhat on my friend's theme, for which I trust that his pardon will be granted.

³ W. Whewell, *History of the Inductive Sciences*, 2 vols., 1st ed., 1837; 3d. ed., 1882. For his account of Mineralogy see 3d., ed., vol. 2, 316-353 (1882).

and decrepit but, once arrived at maturity, persist in the full strength of their powers, even increasing these from time to time. The gods themselves learn from experience.

It is of great interest to read in the pages of Whewell of the struggles of the early mineralogists to unravel the complex knot that confronted them, from the days when little or no distinction was made between a mineral and a rock, through the early studies of Steno, who first showed that the angles of rock crystal were constant, to the days of Romé de Lisle and Haüy, who laid the foundations of modern crystallography. The early attempts at classification of minerals are also instructive. First came the Natural History System of Mohs, about 1820, following the lines laid down by Werner, according to which minerals were classified by their external characters alone. About the same time Berzelius proposed his purely Chemical System, in which minerals were arranged according to the basic or electropositive elements, with little or no regard for the physical characters. When the phenomenon of isomorphous replacement was definitely formulated by Mitscherlich in 1822, although it had been first suggested by Fuchs in 1815 under the term "vicarious" elements,⁴ Berzelius had to abandon his choice of the positive element and take refuge in the electronegative, from which position he was driven by the fact that isomorphism applies to the electronegative elements as well as to the electropositive. After a period of trials and uncertainty there gradually came into use the present system of classification, based on both the chemical and the crystallographic characters, with the optical and other physical characters as means of identification.

But the modern mineralogist is not, or should not be, satisfied with the discovery of new species, the determination of characters for identification, or the classification of minerals: were these the only aims the science could well be spoken of as a "*fertiges Wissen-schaft*," a term applied to it by one of our most prominent mineralogists in conversation with me nearly forty years ago. The chief aims nowadays are broader and we strive to know how minerals are constituted, how they are formed, their relations to each other, to their conditions of formation and to the Earth, and so on. For such studies the determination of isolated facts

⁴ It might be well to adopt this term, "vicarious," to indicate the replacement of one element by another, without any implication of isomorphism.

and characters is of little interest: what is of most interest and what is most needed is the correlation of the various characters. Such correlation may best be accomplished by cooperation between several workers, each one studying the mineral along the lines in which he is most proficient.

Another most important point, on which special stress is laid, is that the determinations of the different characters or constants should, one may even say must, be made on identical material. That is to say, the optical characters (as the refractive indices), the density, and the other physical characters should be determined on the same material that is used for the chemical analysis. Furthermore, whenever possible, a chemical analysis should be made of material of which the optical and other physical characters are determined, and vice versa. If the material is not identical the chemical and physical data cannot be correlated, and the value of either chemical or physical data is much enhanced if both kinds of data are determined on the same material. Mineralogical literature abounds in examples of uncorrelated determinations, and one can see in the compendia of Dana, Hintze, and Doelter many cases in which elaborate and probably very accurate determinations of, let us say, refractive indices for different wave lengths are reported but unaccompanied by a chemical analysis of the material used. It cannot be said that such determinations are wholly useless, but it is undeniable that much of their usefulness for the broader aspects of mineralogy (and physics), such as the study of the specific effects of the various elements on the physical constants, is lost by this neglect. This point was mostly overlooked among the earlier mineralogists, but at the present time its importance is becoming increasingly recognized.

Another important requisite is that the material studied be homogeneous. Otherwise, obviously, the chemical analysis may be made on material of one composition and the optical determinations on material of another, so that they would not be strictly correlatable. Lack of homogeneity may arise in two ways. The mineral may contain inclusions of foreign matter, sometimes easily visible to the naked eye or under the hand lens, in other cases discernible only by microscopic examination. Or the mineral may be free from inclusions but show a zonal structure from center to border, due to gradual change in composition with growth, brought about by the gradually changing composition of the surrounding medium.

The earlier mineralogists, to whom the modern methods of study of minerals in thin section were unknown, mostly ignored these sources of error, unless the inclusions were so prominent as obviously to invalidate the analysis. The modern worker, however, regards this matter of homogeneity as of prime importance, and it frequently happens that more time is spent in separating material of satisfactory purity and homogeneity, sometimes resulting in obtaining only a gram or less for analysis, than is devoted to the chemical analysis and the optical determinations. For crystallographic investigations lack of homogeneity is comparatively unimportant, especially if it be due to inclusions, although a zonal structure may cause notable error. For optical determinations inclusions are mostly negligible, but a zonal structure demands, of course, that determinations be made on each zone. Both kinds of inhomogeneity will, obviously, affect seriously determinations of density and the chemical analysis.

It should, therefore, be an invariable rule, before beginning the chemical analysis of a mineral, to study thin flakes with the microscope to detect the presence of inclusions and to test the zonal homogeneity by the determination of the refractive indices on many grains, an examination now readily and rapidly carried out with the liquids in common use. Many of the older analyses of minerals are rendered of little value because of the neglect of this precaution. This is especially true of opaque minerals, as modern study by metallographic methods has shown that in many cases material supposed to be homogeneous is really a mixture, so that a metallographic examination should always be made of an opaque mineral, especially one with metallic luster, before its chemical analysis is begun.

A few words may be said of some important differences between modern and the earlier methods of procedure in the study of minerals. For the crystallographic study the early mineralogist was fairly well equipped, inasmuch as the simple type of reflecting goniometer, invented by Wollaston in 1809, permitted reasonably accurate work, as is shown throughout Dana's System by his acceptance of many of the constants measured by Brooke and Miller, Breithaupt, von Rath, and even Wollaston himself in the case of calcite. There followed the more accurate horizontal, two-circle goniometer, and this has recently been more or less replaced by several types of two-circle and three-circle goniometers. The

modern results are more accurate than the old, but there is little difference in principle.

The differences in the determination of the optical characters, such as refractive indices, dispersion, and optic axial angle, show more change in method. In the olden days prisms had to be prepared with considerable labor and time, and I well remember the pride with which in 1889 Professor Fouqué showed me his collection of prisms of feldspar made for his classic studies of this group. Nowadays, the use of refractive index liquids permits of determinations on very small grains, with great ease, rapidity and sufficient accuracy. The modern refractometers should also be mentioned.

It is in the improvements and greater refinements of the chemical analysis of minerals, within the last fifty years or so, that the greatest strides have been made. Not only is the material now much more carefully selected, so as to be truly representative, but new methods have been introduced, which permit of much more accurate determinations, and the advance in apparatus and in purity of reagents is a most striking difference. The analyses, also, are now more complete, in that constituents, formerly neglected as being unsuspected to be present or of supposedly negligible importance, are now commonly determined, although many examples might be given of lamentable incompleteness even now. Up to the early eighties the alkalis and manganese generally and titanium always, were neglected in the analysis of specimens of such groups as the pyroxenes, amphiboles, and olivines: the mutually vicarious roles of hydroxyl and fluorine in topaz and other minerals, first discovered by Penfield, were not suspected, and many other errors of omission were committed, which nowadays would not be tolerated by a tyro in analysis. Also, the methods and the analytical facilities of those days were not quite what they are now: reagents were far from pure, there was no resistant pyrex or Jena glass, and so on. One gets an idea of the difficulties under which the analyst of the first half of the last century labored when one reads Faraday's *Chemical Manipulations*. Indeed, one wonders at the analytical skill of many of the early workers, who managed to determine the chemical composition of many minerals with means that the young student would now look on with contempt. For instance, it is said that Cossa, one of the best Italian mineralogical chemists about the middle of the last century,

congratulated himself because, for the analysis of a certain mineral, he had at his disposal a balance that weighed down to one *centigram*. A chemist would hardly congratulate himself on that today.

To return to the study of the general constitution of minerals, the possibility of isomorphous or vicarious replacement, or the presence of certain constituents in so-called "solid solution," has been mentioned. Such phenomena are of special importance in certain mineral groups, as the feldspars, the pyroxenes, the olivines, and the garnets, to mention only some of the more prominent. To study these properly, that is, to correlate the physical, especially the optical, properties, including density, with the chemical composition, the end-members must be studied and these should be chemically pure. In nature such end-members, as forsterite and fayalite in the olivines, are seldom or never found in a state of satisfactory purity. Thus, in even the purest natural fayalite a little magnesium replaces some iron, and conversely for forsterite. For this reason the Geophysical Laboratory, almost from its inception, began to make the more important rock-forming minerals synthetically, using the purest component ingredients, such as silica, alumina, lime, and magnesia. These "systems" were studied by physico-chemical methods, to determine the melting and inversion points of the crystalline phases, the composition and melting points of the eutectics, and so on. At the same time the optical characters, the density, and the other properties of the pure component substances and their compounds were determined. In this way and by these methods, often very laborious and their study extending over many months or even years, we have now a fairly complete and accurate knowledge of the physical characters of the end-members of some of the more important series of rock-forming minerals, a mass of data that is probably the most important contribution to mineralogy from the Geophysical Laboratory. Latterly, this has been supplemented by systematic study of many natural minerals, a study made quantitatively and accurately possible by the previously acquired knowledge of the chemically pure, artificially prepared end-members. We may thus evaluate with a fair degree of accuracy the specific effects of the different elements on the optical properties, refractive indices, dispersion, etc., the determinations being based on data that would not have the validity or authority that they

have were they based on the necessarily more or less impure end-members or the approximations to end-members that are furnished by nature.

Such end-members of series, and pure minerals in general are simply chemical compounds. Whewellite is calcium oxalate whether it is found in a coal bed or precipitated in a beaker: enstatite is magnesium metasilicate whether it forms part of a gabbro laccolith or is formed artificially in a platinum crucible heated in an electric furnace under exactly controlled conditions as to temperature, rate of cooling, etc. But in the former case of each the material is almost invariably contaminated, so that its optical characters, density, and melting point are seriously affected; whereas in the latter the composition of the substance is invariable and thus its physical characters are true and are reproducible.

These considerations lead to the thought that much too little attention is paid by chemists in papers and text-books to the statement of the crystallographic and the optical and other physical properties of the pure chemical compounds that are made in the laboratory. Most chemists are content, in the description of a new substance, to state that it crystallizes "in glistening needles," with no determination of the crystal system, or, if this be given, with no statement of the axial ratios or other crystallographic constants. There is scarcely ever any determination of the refractive indices or other data, the author contenting himself for the most part, with determination of the melting point (often very crude) and the density, done solely for purposes of identification. To give an example. The other day, on seeing some sublimed crystals of camphor in a bottle, the question arose as to its system of crystallization. The various standard text-books on organic chemistry, and even a well-known work on the identification of organic substances, gave no more information than that camphor crystallizes in "glistening prisms." Beilstein (Vol. III, p. 485) stated, on the basis of an observation in 1859, that it crystallizes in the hexagonal system. But, on turning to Groth's *Chemische Krystallographie* (Vol. 3, p. 687, 1910), written by a mineralogist, the system was found to be rhombohedral, and full crystallographic data were given. It would seem that modern mineralogists set a good example to their chemical brethren.

Finally, the latest method of studying minerals must be mentioned, that of study by the X-rays, according to the methods of Laue, the Braggs, and others. The utility of this has been shown recently in the Geophysical Laboratory, by work done on the pyroxene group, a work that serves also as an example of mutual cooperation, one of us (Merwin) doing the optical part, another the chemical, and a third the X-ray study. It would be unjust to my colleague, Dr. Wyckoff, to steal his thunder by giving here his results, but it may be said that his X-ray studies have shown clearly that certain minerals that for many years have been reckoned as pyroxenes can not belong to this group, their molecular structure being quite different.

Study of minerals along such lines is still in its infancy, but such examples as have come under my notice lead to the conviction that X-ray methods, especially when employed in conjunction with some of those longer known, are not only the most recent but among the most powerful methods of arriving at an understanding of what minerals, as well as artificial crystals, really are, how they are constituted, and how they are related.

It should again be said, in conclusion, that all determinations are to be made on identical material. The motto of Belgium may serve as a fitting summing up of my remarks—"L' Union fait la Force."

STUDIES IN THE MICA GROUP (ABSTRACT)¹

A. N. WINCHELL, *University of Wisconsin*

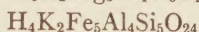
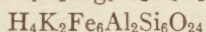
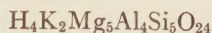
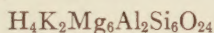
In micas, as in other silicates, each crystal is an aggregate of several intergrown space-lattices which differ decidedly from each other in the size of their atoms. The oxygen space-lattice in mica includes F and H (as OH), but none of the other constituents. The formulas of micas omitting O, H and F, can be deduced from a study of a tabulation of the best analyses calculated into relative numbers of atoms (with the same omission) expressed as percentages.² From such a study it appears that micas are not orthosilicates, nor metasilicates, nor any other single type of silicates,

¹ The complete article on the micas will appear in an early number of the *American Journal of Science*.

² This method is more accurate than the ordinary procedure because the determination of the precise percentages of F and H₂O is notoriously very difficult.

since the percentage of silicon is not constant, but shows considerable variation in each kind of mica. Further, it appears that there are two classes of micas, one characterized by seven atoms (excluding O, H and F) in the fundamental unit, as in KAl_3Si_3 , and the other characterized by eight such atoms, as $\text{KMg}_3\text{AlSi}_3$. The first class, with seven atoms, is here named the heptaphyllite system and the second class, with eight atoms, may be called the octophyllite system.

In the octophyllite system the chief variations in composition are from $\text{KMg}_3\text{AlSi}_3$ to $\text{KFe}_3\text{AlSi}_3$ and from $\text{K}(\text{Mg},\text{Fe})_3\text{AlSi}_3$ to $\text{K}(\text{Mg},\text{Fe})_{2.5}\text{Al}_2\text{Si}_{2.5}$, or, to avoid fractions, from $\text{K}_2(\text{Mg},\text{Fe})_6\text{Al}_2\text{Si}_6$ to $\text{K}_2(\text{Mg},\text{Fe})_5\text{Al}_4\text{Si}_5$. These two variations imply the existence of four chief molecules in the system, namely, including O and H:



By using these four molecules as the corners of a square, all variations in the system can be shown, a single point representing each analysis. After plotting many analyses (80+) on the square, it is clear that nearly all parts of the system are represented in nature, and that the system is continuous from phlogopite ($\text{H}_4\text{K}_2\text{Mg}_6\text{Al}_2\text{Si}_6\text{O}_{24}$) to siderophyllite ($\text{H}_4\text{K}_2\text{Fe}_5\text{Al}_4\text{Si}_5\text{O}_{24}$), and probably to the other two molecules. The optic properties and their variations in all parts of the system can be shown on the same square by means of lines of the nature of contour lines.

There seem to be four independent molecules in the heptaphyllite system of micas which may be written as follows:—

NAME	WITHOUT OH	WITH OH
Muscovite	KAl_3Si_3	$\text{H}_4\text{K}_2\text{Al}_6\text{Si}_6\text{O}_{24}$
Polyolithionite	KLi_3Si_3	$\text{H}_4\text{K}_2\text{Li}_6\text{Si}_6\text{O}_{18}$
Phengite	KAl_2Si_4	$\text{H}_4\text{K}_2\text{Al}_4\text{Si}_8\text{O}_{25}$
Protolithionite	$\text{KFe}_{1.5}\text{Al}_2\text{Si}_{2.5}$	$\text{H}_4\text{K}_2\text{Fe}_3\text{Al}_4\text{Si}_5\text{O}_{22}$

The variations in tenor of oxygen are considered improbable and unsatisfactory, but, nevertheless, no better solution has been found.

Micas of the heptaphyllite system usually contain three of these molecules, but rarely contain all four of them. Therefore the analyses may be plotted on the four triangular sides of a tetrahedron. When this is done it appears that the heptaphyllite system

is discontinuous, consisting of two parts, namely, muscovite—mariposite, and lepidolite—protolithionite.

The optic properties and their variations in both parts of the system can be shown by the use of lines like contours on the same kind of diagram used for studying the variations in composition.

In general, octophyllite is dark colored and heptaphyllite is light colored, but this distinction is not reliable any more than any corresponding color distinction in other silicate groups of minerals. Colorless mica may belong to the octophyllite or biotite system and black mica may belong to the heptaphyllite or muscovite-lepidolite system. In fact, in several cases, micas have been called "biotite" because of their color, which actually belong to the heptaphyllite system.

In nearly all cases octophyllite has the optic plane parallel to (010) and the optic angle smaller in red light than in blue light, while the reverse conditions are found nearly always in heptaphyllite.

MEMORIAL OF THOMAS L. WATSON

H. RIES, *Cornell University*

In the death of Thomas L. Watson, State Geologist of Virginia, and Head of the Department of Geology at the University of Virginia, geology and mineralogy have suffered a severe loss.



THOMAS L. WATSON
1871-1924

When Doctor Watson graduated from the Virginia Agricultural and Mechanical College in 1890, it had been his original intention to enter chemistry as a profession, but his strong interest in geology together with a feeling that his native state, Virginia, possessed valuable resources which afforded a great field for study and development, turned him aside from his original plan.

It was therefore not unexpected to find him taking his graduate work in geology first at the University of Virginia, and later at his alma mater, where he received his Master's degree in 1893. In 1895 he went to Cornell University, and took his doctorate there in 1897.

Subsequent to graduation he held positions as instructor in geology and mineralogy at the Virginia Polytechnic Institute, from 1892-5; assistant chemist at the Virginia Experiment Station, 1890-5; private research worker on rock decay, United States National Museum, 1897-8; assistant State Geologist of Georgia, 1898-1901; professor of geology, Denison University, 1901-4; geologist, Georgia Geological Survey, 1902; geologist, North Carolina Geological Survey, 1903; field assistant, United States Geological Survey, 1903-8; and professor of Geology, Virginia Polytechnic Institute, 1904-7.

He was appointed professor of economic geology in the University of Virginia in 1907, and promoted to head professor of the School of Geology in the same institution in 1910.

In 1908 when the Virginia legislature revived the Virginia Geological Survey, Watson was selected as State Geologist and Director.

This appointment to the professorship at Charlottesville and to the Directorship of the State Survey were not only gratifying to him, but represented a wise move on the part of the University and Geological Survey Board, for there was probably no man better fitted to carry on the work than he was. Virginia was his native state, he was thoroughly familiar with it, and welcomed the opportunity to serve it. Indeed he labored unceasingly in the interests of the Survey and the University up to the time when he was forced to bed by his last illness.

During his term of service as State Geologist, he had prepared over 20 reports dealing with various branches of Virginia geology, as well as a number of maps. To the preparation of these, he gave much cooperation and supervision, and while he wanted work completed as promptly as possible, speed was never allowed at a sacrifice of accuracy or thoroughness.

While Doctor Watson had a remarkably broad grasp of geology as his publications show, he was especially interested in economic geology, mineralogy and petrography.

In the earlier years of his career he devoted much time to economic and petrographic problems of the southeastern states, his contributions on the granites and other igneous rocks of the south being noteworthy. He also prepared several reports on the mineral deposits of Georgia while with the geological survey of that state.

In later years his researches were naturally restricted more to Virginia, in which state he found a wealth of material to interest him.

Among his most important pieces of petrographic and mineralogic works, in addition to that on the southern granites already mentioned, are those on the emery deposits of Pittsylvania County, Virginia, in which among other things he identified the mineral hoegebomite, not hitherto found outside of the Routivare iron district of Lapland; and the remarkable rutile-bearing rocks of Nelson County. It was from this latter area with its interesting igneous complex, that he described the curious rutile-ilmentite-apatite rock, which he named nelsonite.

Numerous other mineralogic and petrographic papers, many of them describing rare types of rock occurrences, and interesting minerals in the south, swell the list of his important contributions in this line.

No less important, however, were his many contributions to economic geology, and his papers which deal chiefly with the useful mineral deposits of the southern states are all the more authoritative because of his wide personal familiarity with them in the field.

One of his largest works was that on the Mineral Resources of Virginia prepared in connection with the Jamestown Exposition, which set forth with care and detail our existing knowledge of the geology and mineralogy of the state.

Doctor Watson was also co-author with the writer of two text books on engineering geology. He was busy correcting proof of a new edition of the larger one the day he was taken to the hospital, and did not live to see it completed.

In his teaching work at the University, Watson exhibited the same interest and attention to detail that he did in everything else. His pedagogic work could not help but be successful and stimulating because he had at hand a store of facts gathered over a long period of practical field work, and he understood how to use them to best advantage.

A problem to which Doctor Watson had devoted much time and thought, and on which he had published not a little, but had a still greater quantity of unpublished data, was the weathering of rocks and minerals, and here his knowledge of chemistry and

mineralogy was of great assistance. Those papers of his which had appeared dealt chiefly with the weathering of granites.

In 1921, when the Mineralogical Society began a consideration of the Nomenclature and Classification of Minerals, Dr. Watson was appointed Chairman of the Committee, in charge of the work. Two reports of this committee have already appeared in the *American Mineralogist*.

There were several things which contributed materially to Watson's success as a geologist and mineralogist. One of these was the broad and intense nature of his interest in these subjects. A second was his remarkably fine memory for facts, which applied not only to those he had observed personally, but also those which had been recorded by others. In fact he possessed a remarkable knowledge of scientific literature, and knew where to go for information on almost any geologic topic. A third was his remarkable energy, and the expedition with which he turned out work.

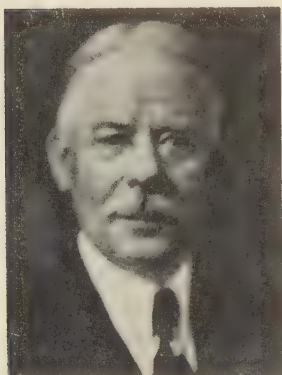
The writer of this biography had known Doctor Watson intimately for many years, and while he held him in high regard as a scientist, the human traits of his character appealed to him especially. He possessed a peculiar quality of making friends and through his spirit of loyalty of retaining them. Moreover his modesty combined with the inborn characteristics of a gentleman never failed to win respect and attention, even from those who knew him casually. He was a strong advertiser of the State of Virginia, but he never advertised himself.

Dr. Watson was a fellow and councillor of the Mineralogical Society of America, fellow and past councillor of the Geological Society of America, member of the Society of Economic Geologists, American Institute of Mining and Metallurgical Engineers, Seismological Society of America, Washington Academy of Sciences, Washington Geological Society, and American Association for Advancement of Science. He was also a member of Phi Beta Kappa and Sigma Xi.

MEMORIAL OF EDMOND OTIS HOVEY

HERBERT P. WHITLOCK, *American Museum of Natural History*

By the sudden death on September 27 of Dr. Edmond Otis Hovey, the circle of his many friends has suffered a severe loss and American science has been rendered the poorer to the extent of



EDMOND O. HOVEY
1862-1924

(Photograph by courtesy of Am.
Museum of Nat. History)

an unique and commanding personality, and a vigorous and conscientious worker in his chosen field. Dr. Hovey possessed that rare combination, so essential to constructive science, of a fertile and idealistic imagination and a painstaking devotion to detail which never stopped short of the truth. His many contributions to literature were characterized by careful and clear cut accuracy of statement which rendered all his utterances authoritative.

He was born in New Haven, Connecticut, on September 15th, 1862. His father, the Rev. Howard Carter Hovey, was an amateur geologist of no mean ability, being a Fellow of the Geological Society of America having

specialized in the geology of caverns. It was through him, no doubt, that Edmond Hovey early acquired the taste for geology which shaped his later career, and paved the way for his life's work.

His early education was acquired in the public schools of Peoria, Illinois; Kansas City, Missouri; and New Haven, Connecticut, so that, when at the age of 18 he entered Yale University; he had already traveled considerably over this country and had had his ideas broadened by contact with a variety of places and people.

Upon graduation he became a teacher going first to Jamesville, and Elk River, Minnesota as principal and superintendent of schools. The year 1886 saw him back at Yale as a graduate student and assistant in the Mineralogical Laboratory of Sheffield Scientific School. Here he had the singular good fortune of studying under two eminent American teachers, James D. Dana and Samuel L. Penfield. When in 1889 he was given his degree of Doctor of Philosophy, he had been for a year assistant principal of the Water-

bury High School, and had been married to Esther A. Lancraft of New Haven. A year after taking his doctor's degree, Mr. Hovey went to Europe, spending the greater part of 1890-91 in Heidelberg, where he studied under Professor Rosenbusch, and upon his return to Waterbury, became principal of the High School.

So studying and teaching Edmond Otis Hovey rounded out the period of his preparation for a career of distinction and responsibility as a geologist, and, influenced by the teaching of such men as the elder and the younger Dana, Penfield and Rosenbusch, it was inevitable that his geology should be based upon a broad and substantial foundation in which mineralogy played no small part.

The opportunity to enter the field of professional geological work came in 1892 when he was appointed superintendent of the Missouri State Exhibit of Minerals at the Columbian Exposition. When this collection of lead, zinc and iron ores, together with other economic minerals, was assembled in Chicago in 1893, the high quality of the work done in displaying the various minerals won for Dr. Hovey his appointment as assistant Curator in Geology at the American Museum of Natural History. Here working under the late Professor Robert Parr Whitfield, Dr. Hovey may be said to have begun the second period of his life, that in which he emerged as a professional geologist. His period of service in the American Museum lasted for thirty years, and was only terminated by his sudden death. In 1901 Dr. Hovey was advanced to the post of associate curator, and upon the death of Professor Whitfield in 1910 he became Curator of Geology.

These 30 years, covering as they do the time of intensive growth of a great educational institution, gave full play to the talents which Dr. Hovey had developed while a teacher and a student. Not that he ever ceased to be either, but his teaching now reached to the wide compass of the "man in the street" and his studies were stimulated and inspired by contact with a great wealth of scientific material. Always a traveler it now became his duty to travel widely in the service of the Museum, and some of its most notable specimens and suites of specimens are the results of his journeys. Among the most noteworthy of these geological pilgrimages were those that he made in 1902, to study the active volcano of Mount Pelée, Martinique, and that which he under-

took in 1915 when he led the Croker Land Expedition for the relief of a party of explorers sent out the preceding year. It is highly significant that, of the one hundred and fifty papers that constitute his contributions to the literature of geology, the last to appear (*American Journal of Science*, September 1924) dealt with the geology of northwest Greenland, and was based upon his observations made upon this expedition. One has but to read the clear, crisp statements embodied in this paper, the materials of which were acquired amid notable hardships, to form a picture of the indomitable devotion and energy that characterized all of his work.

Among the most important services that Dr. Hovey has rendered to geological science were those which fell to his lot as secretary of the Geological Society of America for sixteen years (1907-1922), and as recording secretary and editor of the *New York Academy of Sciences* for nine years (1907-15). In both of these organizations, during the period of his incumbency, Dr. Hovey's influence was potent and active, but particularly was his energy and administrative ability valued in the conduct of the affairs of the former. When in 1922, he found that the pressure of work no longer admitted of his retaining the secretaryship of the Geological Society, that body presented him with a loving cup in appreciation of his notable service.

But of far more value than any such material token is the memory that Dr. Hovey leaves among us who survive him. It has been truthfully said that the real test of a man's work and influence comes after he has passed away, and this is essentially so because those among us who have succeeded in our professions to the extent of bringing the light of knowledge to many people, leave a gap which is hard to fill. They are missed. Edmond Otis Hovey has left such a gap, he is and will be missed by very many.

PROCEEDINGS OF THE FIFTH ANNUAL MEETING OF
THE MINERALOGICAL SOCIETY OF AMERICAFRANK R. VAN HORN, *Secretary*

The Mineralogical Society of America held its fifth annual meeting at Cornell University, Ithaca, New York, on Wednesday, December 31, 1924 at 9 A.M., in conjunction with the Geological Society of America. Both morning and afternoon sessions were in charge of the President, Dr. Henry S. Washington, who gave his presidential address on "*The Modern Study of Minerals*" at 12:20 P.M., before a joint session of the Mineralogical Society of America and the Geological Society of America. This paper is printed in full in this number.

At 9 A.M. the Society proceeded with the regular order of business. On motion of the Secretary, the reading of the minutes of the last annual meeting was dispensed with in view of the fact that they have been printed on pages 56-69 of Volume 9, (Number 3) of *The American Mineralogist*.

ELECTION OF OFFICERS AND FELLOWS FOR 1925

The Secretary announced that 128 ballots had been cast for the officers and fellows for 1925, as nominated by the Council. All 128 ballots for officers were in the affirmative. For fellows, there were 57 in the affirmative and one in the negative for certain nominees. All officers and fellows as nominated were declared elected.

The officers elected for 1925 are the following:

President: Arthur S. Eakle, University of California, Berkeley, California.

Vice-president: Herbert P. Whitlock, American Museum of Natural History, New York City.

Secretary: Frank R. Van Horn, Case School of Applied Science, Cleveland, Ohio.

Treasurer: Alexander H. Phillips, Princeton University, Princeton, New Jersey.

Editor: Walter F. Hunt, University of Michigan, Ann Arbor, Michigan.

Councilor, 1924-1928: William F. Foshag, United States National Museum, Washington, D. C.

The list of Fellows elected follows:

Wilbur S. Burbank, United States Geological Survey, Washington, D. C.

Lazard Cahn, Colorado Springs, Colorado.

Francis D. Dodge, Brooklyn, New York.

Ernest E. Fairbanks, United States Bureau of Mines, Reno, Nevada.

James G. Manchester, New York City.

J. J. Runner, Iowa State University, Iowa City, Iowa.

Otto von Schlichten, University of Cincinnati, Cincinnati, Ohio.

Alfred Wandke, Guanajuato, Mexico.

Samuel Weidman, University of Oklahoma, Norman, Oklahoma.

Edward Wigglesworth, Boston Society of Natural History, Boston, Massachusetts.

Joseph P. Wintringham, Brooklyn, New York.

REPORT OF THE SECRETARY FOR 1924

The Secretary reports that the roll of the Society now comprises 97 fellows and 189 members, a gain of 22 fellows and a loss of 10 members for the year. Several

members have been dropped on account of non-payment of dues. Two fellows, Dr. E. O. Hovey and Dr. T. L. Watson, have died. In addition to the 286 fellows and members, there are also 111 subscribers, chiefly libraries and colleges, so that there are 397 paid copies of the Journal mailed monthly. It is requested that every effort be used to increase the number of members and subscribers, in order that additional funds may be secured to enlarge the size of the Journal.

Respectfully submitted,

Frank R. Van Horn, *Secretary*

President Washington made a few appropriate remarks on the recent deaths of two fellows, Dr. E. O. Hovey and Dr. T. L. Watson.

REPORT OF THE TREASURER FOR 1924

The report was read by the Treasurer. On motion it was accepted and ordered filed. On motion, an auditing committee was appointed by the President, which consisted of Dr. W. T. Schaller and Prof. E. H. Kraus. This committee later reported to the Secretary that they found the books of the Treasurer correct. In view of the favorable financial balance, the Council has ordered an eight percent increase in the size of the Journal for the ensuing year.

To the Council of the Mineralogical Society of America: The Treasurer herewith submits his annual report for the year ending November 30, 1924.

RECEIPTS

Cash on hand, December 1, 1923.....	\$ 432.78
Dues and subscriptions.....	1,258.19
Advertising.....	236.60
Sale of back numbers, etc.....	85.41
Sale of Goldschmidt's Methods.....	21.51
Illustrations charged to authors.....	92.56
Interest on bonds and bank deposits.....	41.36
	<hr/>
	\$2,168.41

EXPENDITURES

Printing Journal.....	\$1,812.43
Miscellaneous printing.....	33.10
Postage.....	33.01
Stationery.....	10.96
Miscellaneous.....	27.35
	<hr/>
	\$1,916.85
Balance in the Princeton Bank and Trust Company.....	251.56
	\$2,168.41

Respectfully submitted,

Alexander H. Phillips, *Treasurer*.

REPORT OF THE EDITOR FOR 1924

The report was read by the Editor, and on motion it was accepted and ordered filed.

To the Council of the Mineralogical Society of America:

Continued progress can be reported for the year 1924. In fact, in many respects, this year has been the banner year. Never before has the volume been as large or contained as many original articles. The forty-eight leading articles in volume 9 represent contributions from twenty-four Universities and research bureaus. It is interesting to note that papers published this past year came from institutions bordering on the Atlantic to those touching the Pacific, from institutions as far north as the University of Alberta to the University of Arizona to the south; and one article was received from Oxford, England, a striking testimonial of the extensive service rendered by The American Mineralogist in supplying an outlet for mineralogical research.

The current volume, No. 9, contains 245 pages of text proper, which compared with the 232 pages of volume 8, indicates an increase of 13 pages or 5.6 % over 1923. The steady increase which has marked the progress of the Journal during the past few years while not of great magnitude in any single year has, nevertheless, been substantial and consistent. The 245 pages of 1924, when compared with the 150 pages of 1919, indicates more clearly what has been accomplished in this five year period—a gain of 63% in the size of our publication.

This past year the forty-eight original articles occupied 68% of the total space of the Journal, proceedings of societies, notes and book reviews 17%, while the remaining 15% was devoted to abstracts, including discussions of new minerals. There has also been an increase in the number of cuts used as shown by the 61 illustrations compared with 39 of the previous year. While these cuts add considerably to the cost of printing, in many instances the author, or the institution fostering the investigation, was willing to bear the entire cost of these reproductions or a portion thereof, thus reducing the net cost to the Society. This policy seems necessary where numerous cuts are involved in a single article.

The concluding table of contents summarizes the distribution of subject matter in volume 9.

DISTRIBUTION OF SUBJECT MATTER IN VOLUME 9

<i>Subject</i>	<i>Articles</i>	<i>Pages</i>	<i>% of total</i>
Original articles.	48	166½	68.0
Proceedings of societies.	22	32	17.1
Notes and news.	49	7	
Book reviews.	6	3	
Abstracted accounts of new minerals.	23	12½	14.9
Abstracts of mineralogic literature.	151	24	
Total of Text.	299	245	100.0
Illustrations.	61		
Covers, advertisements, index.		83	
Total.		328	

Respectfully submitted,
WALTER F. HUNT, *Editor*.

REPORT OF THE COMMITTEE ON NOMENCLATURE AND
CLASSIFICATION OF MINERALS

The work of the Committee was delayed by the death of the chairman, Professor Thomas L. Watson, and the Council voted that Professor Esper S. Larsen be added to the Committee and that Dr. Henry S. Washington assume the duties of chairman. The Committee now consists of H. S. Washington, W. F. Foshag, A. F. Rogers, T. L. Walker, E. T. Wherry, and E. S. Larsen. Dr. Washington reported that he had not been able to secure the various reports from Dr. Watson's assistants, and as a result the final reports on Topic 5, The Numbering of Mineral Species, and Topic 6, The Nomenclature of Isomorphous Groups, were not ready for publication.

A brief preliminary report was made on pronunciation of mineral names, and this report is to be mimeographed and mailed out to the membership during the year. Dr. Washington reported that the Washington, D. C. members had discussed our various reports with Dr. Spencer of England who had suggested an International Committee.

Professor E. H. Kraus moved that a Sub-committee of our Committee on Nomenclature be appointed by its Chairman to cooperate with a similar British committee. This motion was seconded and carried. Dr. W. T. Schaller suggested that the occasion of the next International Geological Congress would also be suitable and proper for a common meeting of the various National Mineralogical Societies which could discuss nomenclature and classification of minerals from an international standpoint. The Mineralogical Society of America may congratulate itself on being the initial sponsor of such a committee which may obtain results of international character.

PRESENTATION OF PAPERS

There being no further business, the Society proceeded to the reading of the papers. The papers presented, with short abstracts, follow:

CLARENCE S. ROSS and EARL V. SHANNON: *Bentonite and Montmorillonite*. The present study of bentonite, which is a clay-like material of very wide distribution and peculiar physical properties, is based largely on an examination of nearly 300 thin sections and 30 new analyses. It is derived from volcanic ash, that has sometimes been reworked and mixed with detrital matter, but often the volcanic structure is perfectly retained. It is usually made up of varying proportions of volcanic rock, phenocrysts and a very characteristic clay-like mineral of the ground-mass, which is a devitrification product of glass. This mineral is found to be montmorillonite to which a new formula has been assigned on the basis of new analyses of pure material from bentonites, pegmatites and the original French montmorillonite. A few bentonites are characterized by another clay-like mineral which is probably identical with the gouge clay called leverrierite by Larsen and Wherry. Many other clay minerals have been studied and information gained of their mineral identity and physical properties. Peculiarities of water content are supposed to be largely an adsorptive phenomena, and this and many of the other unusual physical properties are probably dependent upon the micaceous structure of the mineral, the small cohesion between lamellae, and the ability of water to penetrate between and separate these lamellae.

EDGAR T. WHERRY: *Bentonite as a One Dimensional Colloid*. Crystals may fall simultaneously into size-classes, for example, be of microscopic diameter but colloidal thickness; this is particularly likely to occur when they are formed by some sort of devitrification or development of a meta-colloid. Bentonite and related substances have been shown to result from the alteration of volcanic ash. They exhibit optical and physical properties which indicate that their grains are of visible dimensions in two space-directions, but sub-microscopic and colloidal in the third, perpendicular to the mica-like plates. Their remarkable powers of adsorption are thought to be connected with this dimension relation.

EDGAR T. WHERRY: *A Tabulation of the Aluminum Silicate Minerals* (Abstract read by F. R. Van Horn). A series of aluminum silicate minerals is plotted in a triangular diagram, with alumina and silica at the corners, and water on a medial line, and selection of minerals from the many in the literature made on the basis of their Si:Al ratios falling into the harmonic series N-3. Colloidal, meta-colloidal and crystallized representatives of each ratio are then picked out, and tabulated alongside the diagram, as probably comprising the existent mineral species. Dana's bauxite, schrotterite, and montmorillonite are omitted, but many of his varieties are raised to species rank. Some of the newly created species are apparently of more frequent occurrence than kaolinite. It is hoped that this note will lead to further work on correlating optical and chemical properties in such minerals.

A. N. WINCHELL: *Studies in the Mica Group*. An extensive abstract of this paper is published as a separate article in this number.

A. N. WINCHELL: *A New Theory of the Composition of the Zeolites*. The author has studied the composition of various zeolites by a graphic method which is designed to show whether there is any relation between variations in the soda-lime ratio and the silica-alumina ratio.

From this study it appears that, with a few exceptions which can reasonably be explained as due to secondary changes after formation of the crystals, the zeolites show no evidence of isomorphous replacement under valence-control (so that 2Na replaces Ca, or *vice versa*), but, they are either of fixed composition, like natrolite and mesolite, or they vary in composition exactly as the feldspars do; that is, contrary to the views of all authorities, variation occurs by replacement of Ca by Na (or K) with simultaneous replacement of Al by Si. The isomorphous molecules are composed of the same number of atoms; and the atoms are divisible into three groups, the smallest oxygen atoms, the intermediate Al and Si atoms, and the largest Ca and Na atoms; in all zeolite molecules the oxygen atoms are just twice as numerous as the (Al+Si) atoms, while the number of (Ca+Na) atoms is constant in each part of the zeolite group whose molecules are capable of forming mix-crystals, but differs widely in different parts of the whole group. This theory of the isomorphous relationships of the zeolites can be tested by comparative studies of the composition of zeolites under varying conditions of the solutions surrounding them. If the theory is correct, it can be used to learn something about the nature of solutions in given regions.

ARTHUR S. EAKLE: *Camsellite from California*. Boulders of serpentine on the eastern shore of Bolinas Bay, California, are coated and impregnated with soft, white, minutely fibrous camsellite. Analyses show that camsellite is a silico-borate instead of a simple, hydrous magnesium borate and has the formula, $2(\text{MgO} \cdot \text{FeO})(\text{B}_2\text{O}_3 \cdot \text{SiO}_2) \cdot \text{H}_2\text{O}$.

ARTHUR S. EAKLE: *Foshagite, a New Calcium Silicate from Crestmore, California.* Large vesuvianite boulders contained veins of a white, compact, fibrous mineral, which analyses show is a new silicate corresponding to the formula, $\text{H}_2\text{Ca}_6(\text{SiO}_4)_3 \cdot 2\text{H}_2\text{O}$. The mineral was named foshagite and was found associated with thaumasite in the Wet Weather Quarry of the Riverside Portland Cement Company at Crestmore, California.

ARTHUR S. EAKLE: *Note on the Crystallization of Thaumasite.* Glassy granular thaumasite is intimately associated with the foshagite at the Wet Weather Quarry of the Riverside Portland Cement Company at Crestmore, California. Many of the apparent grains are doubly terminated hexagonal prisms which gave good readings on the goniometer.

At 12:15 P.M. the Society adjourned to the auditorium of the Baker Chemical Laboratory for a joint session with the Geological Society, at which President Washington gave his address on, *The Modern Study of Minerals*. At 2:15 P.M. President Washington called the meeting to order in McGraw Hall, and proceeded with the reading of papers.

EDWARD F. HOLDEN: *The Temperature-Pressure Conditions During the Formation of Smoky Quartz and Amethyst.* Quite precise information concerning the temperature and pressure conditions during the formation of smoky quartz and amethyst is afforded by the abundant and comparatively large liquid- and gas-filled cavities. Contraction bubbles in the water inclusions disappear when the specimen is heated to the temperature of formation. Heating was carried on in a paraffine oil bath on a microscope stage. The proportion of liquid and gas phases in CO_2 inclusions indicates the pressure at the time of formation, if the temperature is known. The simultaneous presence, in a fragment, of water and CO_2 inclusions, allows both temperature and pressure to be calculated. Smoky quartz was formed at 110–225 degrees, and less than 100–175 atm.; amethyst at 100–250 degrees and up to 600 atm. pressure. 26 specimens were examined.

T. L. WALKER and A. L. PARSONS: *Evanescent Pink Sodalite or Hackmannite from Bancroft, Ontario.* Sodalite from the original locality described in Greenland was said to show at first a pink color which disappeared rapidly on exposure to daylight. This peculiar property was largely forgotten by mineralogists until a century later Vredenburg called attention to a similar sodalite from Rajputana. Recently the writers discovered the same type of sodalite in the neighborhood of Bancroft, Ontario. The mineral is associated with nephelite, cancrinite, calcite, vesuvianite, essonite and diopside. Freshly broken surfaces are often spotted with the pink mineral. When exposed to direct sunshine, the color usually vanishes in from 10 to 30 seconds. Borgstrom in 1901, described a sodalite of this type from the Kola Peninsula containing 0.39 per cent of sulphur. On account of the evanescent color and sulphur content he regarded it as a new species which he called *hackmannite*.

PAUL F. KERR and CHARLES K. CABEEN: *Electrical Conductivity of Ore Minerals.* The description of an inexpensive electrical conductivity apparatus, equipped with dry-cells and a series of flashlight bulbs, for obtaining the comparative conductivity of ore-minerals. A table of conductivities was given, using common minerals as standards, arranged in convenient form for determinative work.

EDWARD H. KRAUS: *A Computing and Direct Reading Jolly Balance.* By an attachment to the recording Jolly balance described by the author in 1911, the

specific gravity can be read directly from the graduated scale. The attachment is extremely simple and makes use of the ratios between corresponding sides in similar triangles. A balance with the new attachment was used to explain the principle involved and the various operations necessary in determining directly the specific gravity.

CHARLES R. FETTKÉ: *A Calcified Log from the Pittsburgh Coal near Morgantown, West Virginia*. During 1923 a calcified log from the locality given above was obtained. This proved to be of considerable scientific interest on account of the remarkable manner in which the cell structure of the original wood was preserved. Minute details can still be clearly seen with magnifications as high as 200 diameters. Calcite accompanied by a little calcium magnesium carbonate has replaced the woody material, and in places pyrite has replaced the calcite.

LEWIS S. RAMSDELL: *Preliminary Report on the Crystal Structure of Some Metallic Sulfides*. Argentite is usually assumed to be isomorphous with galena. Diffraction patterns made by the powder photograph method from four specimens as well as from artificial Ag₂S are totally different from that of galena. In fact they do not even appear to be cubic. Cinnabar and covellite give patterns which are quite different. Ullmanite has the "pyrite" type of structure with the side of the unit cube about 5.91 Å°.

T. L. WALKER and A. L. PARSONS. *The Characteristics of Primary Calcite in Igneous Rocks*. There are many references in the literature to magmatic or igneous calcite, but no definite physical difference has so far been observed between the supposed high temperature calcite and ordinary calcite. The writers recently found calcite in several localities in crystalline limestone, pegmatite and apatite-calcite vein-dikes that exhibit in a remarkable degree parting parallel to $e(0112)$ with polysynthetic twinning. It is thought by the writers that this may be found to be a universal characteristic of high temperature calcite.

RALPH W. G. WYCKOFF and HERBERT E. MERWIN. *The Space Group of Diopside*. The shape and dimensions of the correct unit cell and the corresponding space group for crystals of diopside were investigated using spectrum and Laue photographs. The general manner of atomic arrangement is deduced from this information. No attempt, however, is made to establish the positions of the atoms in this crystal.

RALPH W. G. WYCKOFF, HERBERT E. MERWIN and HENRY S. WASHINGTON: *X-ray Diffraction Measurements upon the Diopside-like Pyroxenes and their Bearing upon the Nature of Augite*. X-ray powder photographs of various pyroxenes structurally isomorphous with diopside have been measured. These data throw light upon the changes in shape and size of the unit cell of this structure, that result from the isomorphous substitution of atoms of one metal for those of another. They further bear directly upon the problem of the nature and position of the alumina and the ferric oxide in augites. Several supposed solid solutions of diopside and enstatite have also been examined.

AUSTIN F. ROGERS: *The Crystallography of Sucrose*. A study of the forms and combinations of over one thousand crystals of sucrose or ordinary sugar. In addition to the known forms,—(100), (001), (101), ($\bar{1}01$), (110), ($\bar{1}\bar{1}0$), (0 $\bar{1}1$), ($\bar{1}\bar{1}1$), ($\bar{1}\bar{1}\bar{1}$), and (011), two new forms ($\bar{1}\bar{1}1$) and (210) are described. The right sphenoid, (011) occurs on some of the crystals in addition to the left sphenoid (0 $\bar{1}1$), which is present on all the crystals. In sucrose crystals with caramel as an impurity

(brown "rock candy") the caramel is present only at the left end of the b -axis which is polar, (the symmetry of sucrose is A_2).

AUSTIN F. ROGERS: *An Interesting and Useful Property of Zones*. The addition or subtraction of the Miller symbols of two faces of a zone taken index by index gives another face of the zone. This fact has been known for some time, but little use apparently has been made of it. It is useful in a number of ways, but especially in constructing orthographic projections.

AUSTIN F. ROGERS and R. D. REED: *A New Type of Sand Calcite Crystals from Monterey County, California*. Sand calcite crystals have recently been found in the Cholame Hills, Monterey County, California. They occur in a white sandstone of Santa Margarita age and consist of about 35 percent calcite and about 65 per cent sand which is largely quartz. Some of the crystals are well developed, though the edges are rounded and the faces somewhat curved. The crystal form is essentially the negative rhombohedron f (02 $\bar{2}$ 1) and the crystals are almost invariably twinned, the twin plane being the rare positive rhombohedron (20 $\bar{2}$ 1), an exceedingly rare twin-law for the mineral calcite.

W. M. MYERS and ALBERT B. PECK: *A Fulgurite from South Amboy, New Jersey*. (Abstract read by W. F. Hunt). The fulgurite was found in a sand pit but was broken during removal into numerous pieces six inches or less in length. The total length was between nine and eleven feet. It was conical in shape, tapering from a maximum diameter of three inches to a minimum of three sixteenths inch. The color varies from light brown to dull white. The entire surface is coated with partially fused sand grains. A peculiar feature is that for the greater part of its length, the fulgurite is hollow, sometimes being only a thin shell. Petrographic examination shows it to be composed mainly of an isotropic glass with index about that of silica glass. A few needles of mullite are present and some of the quartz grains adhering to the exterior of the fulgurite are partially changed to cristobalite. The glass contains numerous bubble inclusions. These are thought to represent entrapped moisture which was in the sand at the time of fusion or products of the volatilization of silica. Mullite is due to the decomposition or fusion of clay present in the sand.

The last paper was finished at 5:25 P.M. after which Professor E. H. Kraus moved that the thanks of the Society be extended to the local committee, and to the President and Trustees of Cornell University for their kindness and hospitality. This was adopted by a rising vote whereupon the Society adjourned. Fifty-seven fellows and members as well as additional guests and visitors attended the meeting, which was the largest in the history of the Society.

FELLOWS OF THE MINERALOGICAL SOCIETY OF AMERICA

(*Indicates charter fellow. †Indicates charter member before election to fellow.)

- *Adams, Elliot Q., Pure Science Lab., Nela Park, Cleveland, Ohio.
- Alling, Harold L., 901 East Ave., Rochester, N. Y.
- *Ashcroft, Fred'k Noel, 37 Palace Court, Bayswater, London, W 2, England
[Life Fellow].
- *Bascom, Miss F., Bryn Mawr College, Bryn Mawr, Pa.
- *Bayley, William S., Dept. of Geology, Univ. of Illinois, Urbana, Ill.
- Bøggild, O. B., Univ. of Copenhagen, Copenhagen, Denmark.
- *Bowen, N. L., Geophysical Laboratory, Washington, D. C.
- *Bowles, Oliver, U. S. Bureau of Mines, New Brunswick, N. J.
- *Bruce, E. L., Dept. of Mineralogy, Queen's Univ., Kingston, Ontario, Canada.
- Burbank, Wilbur S., U. S. Geological Survey, Washington, D. C.
- †Butler, G. M., University of Arizona, Tucson, Arizona.
- *Buttgenbach, Henry J., 439 Avenue Louise, Brussels, Belgium.
- †Cahn, Lazard, 6 N. 8th St., Colorado Springs, Colorado.
- *Canfield, Frederick A., Dover, N. J.
- *Clark, Robert W., 217 Commerce Bldg., Okmulgee, Oklahoma.
- *Cook, Charles W., Geological Laboratory, Ann Arbor, Michigan.
- *Crawford, R. D., 1050 10th St., Boulder, Colo.
- *Crook, A. R., State Museum, Springfield, Illinois.
- *Dana, Edward S., American Journal of Science, New Haven, Conn.
- †Dodge, Francis D., 291 Henry St., Brooklyn, N. Y.
- *Eakle, Arthur S., University of California, Berkeley, Calif.
- *Ellsworth, H. V., Geological Survey, Ottawa, Canada.
- †English, George L., 50 Brighton St., Rochester, N. Y.
- *Eyerman, John, 2012 La Brea Terrace, Hollywood, Calif.
- Fairbanks, E. E., U. S. Bureau of Mines, Reno, Nev.
- *Fettke, Chas. R., 1118 Wightman St., Squirrel Hill Station, Pittsburgh, Pa.
- *Ford, William E., 876 Yale Station, New Haven, Conn.
- *Foshag, William F., U. S. National Museum, Washington, D. C.
- Gillson, Joseph L., Room 4-338 Massachusetts Inst. of Tech., Cambridge, Mass.
- *Gordon, Samuel G., Academy of Natural Sciences, Philadelphia, Pa.
- *Graham, R. P. D., McGill University, Montreal, Canada.
- *Guild, Frank N., University of Arizona, Tucson, Ariz.
- *Hawkins, Alfred C., 40 Nunda Blvd., Rochester, N. Y.
- Hess, Frank L., U. S. Geological Survey, Washington, D. C.
- †Holden, Edward F., Mineralogical Lab., Ann Arbor, Michigan.
- *Honess, Arthur P., 113 Frazier St., State College, Pa.
- *Hubbard, Lucius L., Houghton, Michigan.
- *Hunt, Walter F., Mineralogical Lab., Ann Arbor, Michigan.
- *Insley, Herbert, Industrial Bldg., Bureau of Standards, Washington, D. C.
- *Johnston, Robert A. A., 197 Bronson Ave., Ottawa, Canada.
- Kerr, Paul F., Dept. of Mineralogy, Columbia University, New York City.
- *Klein, A. Albert, Norton Co., Worcester, Mass.
- *Kraus, Edward H., Mineralogical Lab., Ann Arbor, Michigan.
- *Kunz, George F., 405 Fifth Ave., New York City.

- *Lane, Alfred C., 22 Arlington St., Cambridge, Mass.
*Larsen, Esper S., 3 Oak Ave., Belmont, Mass.
†Lee, O. Ivan, VanDyke and Co., 57 Wilkinson Ave., Jersey City, N. J.
*Lewis, J. Volney, Rutgers College, New Brunswick, N. J.
*Louderback, G. D., Dept. of Geology, Univ. of California, Berkeley, Calif.
*Luquer, L. McI., Dept. of Geology, Columbia Univ., New York City.
†Manchester, James G., 34 Nassau St., New York City.
*Mathews, Edward B., Dept. of Geology, Johns Hopkins Univ., Baltimore, Md.
*McCaughey, William J., Lord Hall, Ohio State University, Columbus, O.
*Merwin, Herbert E., Geophysical Laboratory, Washington, D. C.
Miller, Benjamin L., Lehigh University, South Bethlehem, Pa.
Miller, William J., Univ. of California, Southern Branch, Los Angeles, Calif.
*Moore, E. S., Dept. of Geology, Univ. of Toronto, Toronto, Canada.
*Palache, Charles, 106 Appleton St., Cambridge, Mass. [Life fellow]
*Parsons, A. L., University of Toronto, Toronto, Canada.
*Peck, Albert B., Mineralogical Laboratory, Ann Arbor, Michigan.
*Peck, F. B., Lafayette College, Dept. of Geology, Easton, Pa.
*Phillips, Alexander H., 54 Hodge Rd., Princeton, N. J.
*Poitevin, Eugene, Geological Survey, Ottawa, Canada.
*Porter, Miss Mary W., 6 Tackley Place, Oxford, England.
*Richardson, C. H., Syracuse University, Syracuse, N. Y.
*Ries, H., Dept. of Geology, Cornell University, Ithaca, N. Y.
†Roebbling, Col. Washington A., 191 West State St., Trenton, N. J. [Life fellow]
*Rogers, Austin F., Stanford University, California.
Runner, J. J., Old Science Bldg., Univ. of Iowa, Iowa City, Iowa.
Russell, Arthur E., Swallowfield Park, Reading, Berks., England.
Sampson, Edward, U. S. Geological Survey, Washington, D. C.
*Schaller, Waldemar T., U. S. Geological Survey, Washington, D. C.
Schoep, Alfred, Dept. of Mineralogy, Univ. of Ghent, Ghent, Belgium.
Shannon, Earl V., U. S. National Museum, Washington, D. C.
Steiger, George, U. S. Geological Survey, Washington, D. C.
Taber, Stephen, Dept. of Geology, Univ. of South Carolina, Columbia, S. C.
*Tarr, W. A., 1316 Ross St., Columbia, Missouri.
*Thomson, Ellis, Dept. of Mineralogy, Univ. of Toronto, Toronto, Canada.
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PROCEEDINGS OF SOCIETIES

NEW YORK MINERALOGICAL CLUB

Regular Monthly Meeting of November 19, 1924

A regular monthly meeting of the New York Mineralogical Club was held in the East Assembly Room of the American Museum of Natural History on the evening of November 19th, at 8:15 p.m. The President, Dr. George F. Kunz presided, and there was an attendance of 25 members.

The committee on membership reporting favorably upon the names submitted at the October meeting, viz:—

Mr. G. Arthur Cooper, of Colgate University and Flushing, N. Y.

Mr. R. Norris Shreve, 50 East 41st Street, New York City.

These gentlemen were unanimously elected.

The recording secretary submitted to the membership committee the following names:—

Mr. Lewis W. MacNaughton, 654 Bergen Ave., Jersey City, N. J.

Dr. Paul F. Kerr, Department of Mineralogy, Columbia University.

The recording secretary reporting in behalf of the committee on the Hovey resolution read the following resolution which had been transmitted by the committee to Mrs. Hovey:—

“By the death on September 27th of Dr. Edmond Otis Hovey, the science of mineralogy has lost a valued exponent, and this organization an active and devoted member. Dr. Hovey, through the breadth and scope of his interpretation of his science, held a far closer grasp of mineralogy than many of his colleagues in geology. His many contributions to scientific literature were characterized by a painstaking conservatism which found expression in that clearcut accuracy of statement which is the essence of truth.

In the pursuit of knowledge he found no task too hard, no labor too strenuous, pursuing his investigations among the rigors of the arctic, and to the brink of an active volcano. The patience and courtesy with which he met the many calls upon his time and judgment will long be remembered by those who profited by recourse to his opinion, which was given with the same cheerful impartiality to the lowliest as to the greatest. It is the highest tribute that can be paid to the usefulness of any man in the world, that his loss is felt by so many of his fellowmen.”

The President then introduced the speaker of the evening, Professor George I. Finlay, who delivered an illustrated lecture on "*The Minerals of the Navajo Indian Reservation, Arizona*". Dr. Finlay described the occurrence and probable origin of the garnet and olivine pebbles which constitute the chief contribution of this region to mineralogy. In describing his reconnaissance as an investigator of the oil resources of the Reservation for the U. S. Government, he spoke at length of the geography and geology of the country, which is occupied by 25,000 Indians, and about 100 white men. He showed many lantern slides to illustrate the scenery and geology, comparing the latter with that of the adjoining district of Silverton, Colorado. He also discussed the sand dunes and the Jurassic sandstones. In concluding he spoke at some length of the Navajo Indians and some of their characteristics.

At the close of his lecture a vote of thanks was tendered to the speaker for his interesting and enlightening address. Mr. Manchester read a letter which he had received from Mr. Shannon of Washington relative to the gem garnets which he had previously reported from Kinkles Quarry, Bedford, N. Y. in which Mr. Shannon pointed out that the garnets in question had come from Arizona and not from the Kinkle Quarry.

The meeting then adjourned.

HERBERT P. WHITLOCK, *Recording Secretary*.

PHILADELPHIA MINERALOGICAL SOCIETY

Academy of Natural Sciences, December 11, 1924

A stated meeting of the Philadelphia Mineralogical Society was held on the above date, with the president, Mr. Vaux, in the chair. Twenty-five members and thirteen visitors were present.

The executive council submitted a revision of the by-laws, providing that hereafter all new members of the society under 21 years of age shall become junior members until they reach that age, when they shall automatically become annual members. The proposed changes were adopted. One annual member and six junior members were elected.

Dr. Edgar T. Wherry then addressed the meeting on "*The Aluminum Silicate Minerals*," with particular reference to the kaolins. The minerals of this group may be classified according to structure and composition. They all contain three essential components: Al_2O_3 , SiO_2 , and H_2O . For each composition there are possible three structural states: colloidal, metacolloidal, and crystalline. For purposes of comparison the compositions of the minerals in terms of all three components were plotted on a triangular-shaped diagram using ordinary rectangular coordinates. A table was presented showing the known minerals in each structural state for a number of different ratios of Si : Al. A discussion of some of the individual members of the group, notably bentonite, concluded the paper.

A rising vote of thanks was tendered the speaker for his very interesting communication.

Messrs. Vaux and Gordon exhibited calcite and magnetite crystals from the French Creek Mines. Messrs. Bengé and Thatcher exhibited vivianite from Mullica Hill, N. J.

HORACE R. BLANK, *Secretary*.

PHILADELPHIA MINERALOGICAL SOCIETY

Academy of Natural Sciences, January 8, 1925

A stated meeting of the Philadelphia Mineralogical Society was held on the above date with the president, Mr. Vaux, in the chair. Twenty-six members and two visitors were present. Mr. Harold Arndt was elected councillor for the year 1925. Upon favorable recommendation by the council, Mr. Gustav Baack was elected a junior member. Mr. Cienkowski presented the name of Mr. Robert Kleinschmidt for junior membership. The resignation of Mr. Morton L. Jandorf was read and accepted.

Mr. Paul J. Storm of the University of Pennsylvania addressed the society on "*The rare-earth minerals of Barringer Hill, Texas.*" The geology of Barringer Hill was briefly described. Barringer Hill forms an eminence about 50 feet high, 250 feet long, and about 100 feet wide. It consists of a very coarse pegmatite forming an intrusive in a porphyritic granite. The outer margin of the pegmatite shows a graphic structure. The crystalline minerals of the pegmatite are, quartz, feldspar (albite and microcline intergrowths), biotite, fluorite, and some orthoclase, lepidolite, and hematite. The rare-earth minerals: allanite, cyrtolite, gadolinite, yttrialite, rowlandite, tengerite, nivenite, thorogummite, fergusonite, mackintoshite, and polycrase occur locally, embedded in quartz and feldspar, most frequently near masses of biotite. For 4 to 10 feet in the vicinity of a pocket, the quartz may contain radial cracks pointing to the rare-earth minerals in the center. The rare-earth minerals form less than one percent of the minerals of the pegmatite. Other minerals noted were gummite, autunite, lanthanite, sphalerite, molybdenite (five inch plates), magnetite (thin fan-shaped radiations up to ten inches across, still to be found), and powellite. The hill was worked by trenching in various directions. No work has been done for 18 years. The relative radioactivity of the rare-earth minerals was described. Mr. Vaux exhibited a series of nine of the rare-earth minerals.

Mr. Boyle exhibited several specimens from the Wynnewood Road Station quarry, Haverford township, Delaware County. The first consisted of beryl in pegmatite. The others showed fan-shaped, white radiations of scolecite and natrolite, associated with heulandite and chabazite, on a fine-grained biotite gneiss. The white radiations showed compact centers with the following optical properties: extinction parallel, elongation of fibers +, optically +, $\alpha = 1.475$, $\gamma = 1.487$, $\alpha - \gamma = .012$. This is probably natrolite. This center grades into coarser fibers with a good prismatic cleavage showing a somewhat pearly luster: extinction on cleavage fragments about 12° , optically -, $\alpha = 1.513$, $\gamma = 1.520$, which was identified as scolecite.

SAMUEL G. GORDON, *Secretary pro tem.*

YALE MINERALOGICAL SOCIETY

Since the organization meeting, October 5, 1923, and the first regular meeting on October 16, 1923, there were held six regular meetings of the Yale Mineralogical Society during the academic year of 1923-1924.

On October 30, 1923, Professor A. M. Bateman spoke on "*Ore Minerals Under the Reflecting Microscope.*" The talk was illustrated by views of many polished specimens projected on a screen.

At the next meeting on November 27, 1923, Mr. L. B. Riley, one of our members, read a paper on "*Asbestos Minerals*"; and Professor Adolph Knopf spoke on "*The Uses of the Petrographic Microscope in Mineralogy and Petrology*." Dr. Knopf projected the field of the microscope on a piece of cardboard and explained the significance of mineral intergrowths.

On January 15, 1924, Mr. E. J. Roberts read a paper on "*Lithium Minerals*"; and Dr. C. H. Warren, Dean of the Sheffield Scientific School, spoke on "*The Pegmatites of the Quincy and Cape Ann, Massachusetts, Granites*."

On February 26, 1924, Mr. J. F. Schairer read a paper on "*olumine Isomorphism*." Professor C. R. Longwell spoke on "*The Genesis of Pegmatite Minerals*." The talk was illustrated by drawings and a long discussion followed.

A symposium on "*Tourmaline*" was conducted by the society on April 1, 1924. Over two hundred specimens were on the table for examination and discussion. Professor H. W. Foote led the discussion on the chemical structure; Professor W. E. Ford, the crystallography and physical and optical properties; Professor Adolph Knopf, the occurrence and distribution in nature. Dr. W. M. Agar described the occurrence of the fine black tourmaline near Pierrepont, N. Y.

On May 15, 1924, Dr. S. G. Gordon spoke on "*The Work of the Second Vaux Academy Expedition to Greenland, 1923*." The lecture was illustrated by lantern slides. At the end of the lecture Dr. Gordon was tendered a rising vote of thanks.

The Secretary reported twenty-eight active members on June 1, 1924.

J. F. SCHAIRER, *President*

NOTES AND NEWS

Dr. W. F. Hillebrand, chief chemist of the Bureau of Standards since 1908, died on February 7 at the age of 71 years. Dr. Hillebrand in 1875, jointly with T. H. Norton, prepared for the first time metallic cerium, lanthanum and what was then called "didymium." In 1904 he was one of the first to call attention to the possibility of recovering and utilizing enormous quantities of potash that are volatilized during the burning of portland cement. He also discovered the gas which later Ramsay established as helium. Dr. Hillebrand was the author of numerous articles on chemical methods and his bulletin on "The Analysis of Silicate and Carbonate Rocks" has passed through a number of editions, the latest appeared in 1919 as Bulletin 700 of the United States Geological Survey.

Occasionally this office receives requests for information concerning copies of *The Mineral Collector*. If any of the early subscribers of this periodical desire to dispose of their copies the editor will be pleased to bring the interested parties together.

Mr. I. A. Ettlinger, mining geologist and engineer of New York, reports the finding of clinozoisite at the Hollinger Mine, Porcupine, Ontario. This is adjacent to the Rochester Mine in which E. L. Bruce and C. W. Greenland collected their material (*Am. Min.*, 9, 199-201, 1924). It was low in iron, had anomalous interference colors and indices higher than zoisite. Mariposite was also reported from the same property.

It has recently been demonstrated by Professor Manne Siegbahn of Upsala, Sweden, that X-rays can be refracted as well as reflected by solid substances. The amount of deflection was actually measured by photographic methods.